THE UNIVERSITY OF MICHIGAN
SPACE PHYSICS RESEARCH LABORATORY
DEPARTMENT OF ATMOSPHERIC, OCEANIC AND SPACE SCIENCES
SPACE RESEARCH BUILDING
2455 HAYWARD STREET
ANN ARBOR, MICHIGAN 48109-2143 U.S.A.

P4

Final Report for Grant NAG5-1197 to the University of Michigan

ADP Archival IUE Research in Outer Planet Aurora

John T. Clarke, Principal Investigator

Period of Performance: 1 June 1989 - 31 May 1990

9 August 1990

This project has been in support of an active program of IUE observations of the outer planets, and the archival research has been directed toward studies of Saturn's and Jupiter's auroral emissions in archived IUE spectra. The proposed areas for archival research were:

1) reduction of spectra of Saturn's aurora and airglow obtained during solar minimum, to test both an apparent direct relation between solar activity and the brightness of Saturn's aurora, and an apparent solar cycle dependence of the planetary H Ly α brightness,

2) reduction of Jupiter polar (auroral and non-auroral) spectra for evidence of auroral modification of the hydrocarbon stratosphere, specifically to correlate the strength of FUV absorption bands of C_2H_2, CH_4, and C_2H_6 with latitude, auroral activity, longitude w.r.t. the brightest aurora, etc.,

3) analysis of Jovian FUV auroral spectra obtained during coordinated ground-based IR observations of auroral emissions, for comparison of relative flux levels, strength of hydrocarbon absorption in the FUV w.r.t. IR emission, relative altitude of FUV aurora w.r.t. the hydrocarbon homopause, etc.

The work accomplished to date has been:

1) The Saturn project has been pursued in collaboration with Melissa McGrath of Johns Hopkins University. We have now assembled the complete set of Saturn spectra from the archives, assembled background Ly α spectra for each year for a relative sensitivity correction to the Saturnian Ly α data, and performed a preliminary reduction of the spectra. In this reduction there appears a clear variation of the equatorial Ly α emission brightness, which appears to correlate generally with the solar cycle. There also appears considerable variability in Saturn's auroral Ly α emission , although to date we have not detected any correlation between the auroral emission and the solar cycle. We have submitted an abstract of this work for presentation at the Fall 1990 DPS meeting (see attached).

2) We have also made substantial progress on this project, having received every Jovian auroral spectra from both poles taken since 1981. This project is confined to the range of dates for which SME solar spectra are available, beginning in 1981, since we need to calculate the albedo in the auroral atmosphere. We have concentrated initially on a set of spectra of the north pole within +/- 20° of 180° on the central meridian, i.e. the brightest auroral emission region on the central meridian to within +/- 20°. In this sample we can then study the variability of the auroral atmosphere as a function of auroral brightness under nearly identical observing conditions. We have so far extract the H_2 auroral emission spectra from all of these images, and are hard at work on calculating the albedos and hydrocarbon absorption strengths both in the auroral atmosphere and at sub-auroral latitudes in each image. We have submitted an abstract for the Annapolis Outer Planet Magnetospheres Conference later this month (attached) to present the first results from this work.

3) This project has received a lower priority over the last year, mainly because Jupiter's aurora were unusually faint during the November 1989 IUE/IR campaign. We have reduced the auroral H_2 emission spectra obtained with IUE during the November observations, and provided these to our CFHT observer collaborators. It appears that the episode of fainter UV aurora in 1989 coincided with a lower rotational temperature in Jupiter's ionosphere, as determined from the ratio of 2 to 4 μm emissions from H_3^+ measured from the CFHT. These data are presently being combined with data from the coordinated IUE/IR observations in September 1988, during which the aurora were at a more normal level of brightness.

This summarizes the status of this project at this time. We plan to submit a continuation proposal to the ADP program this fall to pursue these projects, all of which are still in progress, and all of which already are producing interesting results.

John T. Clarke
Assistant Professor

H I Ly-α Emission from Saturn (1980–1990)

M. A. McGrath (Johns Hopkins Univ.), J. T. Clarke (Univ. Michigan)

We report on an ongoing program of observations of Saturn in the far ultraviolet begun in 1980 with the *International Ultraviolet Explorer* (*IUE*) satellite. The data set includes over 120 exposures of Saturn obtained at least once a year between 19 Jan 1980 and 3 April 1990. Using the large aperture ($\sim 8.9'' \times 21''$) aligned $\sim$N-S on the planetary disk ($\sim 15''$ in diameter) we have obtained the spatial distribution of H I Ly-α emission over portions of the planet, determining brightnesses of both the auroral emission, when present, and the the disk Ly-α emission. The data include observations analysed previously by Clarke *et al.* (1981), who detected bursts of auroral Ly-α emission of 300–900R which varied significantly on a time scale of days in both northern and southern hemispheres. The observations made since 1980 confirm the previously established nature of the Saturnian aurorae as being highly variable, marked by a lack of detection of auroral Ly-α bursts and relatively low disk Ly-α brightnesses on 9 separate observing dates between January 1983 and April 1988. Implications of these observations for understanding the power source of the Saturnian aurorae (*i.e.*, external or internal to Saturn's magnetosphere) and the excitation mechanism of the disk Ly-α emission, and their possible relationships to the long-term solar cycle will be discussed.

This work is supported by NASA grant NSG-5393.

Clarke, J. T., H. W. Moos, S. K. Atreya, and A. L. Lane (1981). *Nature* **290**, 226.

#1 31-MAY-1990 16:12:27.33 MAIL

From:
To:
CC:
Subj:

MAIL
S
L
C
A

Mike,

I assume that U3MLK is Mike Kaiser. Here are two abstracts for the Annapolis meeting. Please let me know if you would like me to mail you a spiffy laser-printed version.

Jovian FUV H2 Aurora: Correlations

M. C. Peterson (Univ. Michigan. / U.S.A.F.)
W. M. Harris (Univ. Michigan)
J. T. Clarke (Univ. Michigan)

Press RETURN for more...

MAIL>
#1 31-MAY-1990 16:12:27.33 MAIL

Jupiter's FUV aurora exhibits "bright spots" near 185 North, and 10 South in lambda III coordinates. The bright spots are not uniformly bright in time, indicating variability of particle flux or energy. We are using the IUE data base from 1981 - 1989 to look for correlations between FUV H2 auroral brightness and: H2 color ratio, Ly alpha / H2 ratio, Ly alpha doppler shifts, hydrocarbon abundance, and Io position. The dim and bright auroral cases can be compared to see if atmospheric composition, derived from IUE spectra, changes with auroral intensity. Several hypotheses have been presented which indicate auroral particles either vary in penetration depth, or that Jupiter's atmospheric composition changes with longitude due to the unique energy injection region of the auroral bright spots. We will present results of our analysis with the intent of resolving these questions.

Jupiter's Doppler-shifted Auroral Emissions

Press RETURN for more...

MAIL>
#1 31-MAY-1990 16:12:27.33 MAIL

John T. Clarke (University of Michigan)
J. Hunter Waite (Southwest Research Institute)

Observations of the H Ly alpha line profile in Jupiter's aurora have not shown any detectable Earth-like proton precipitation, but have shown low-energy Doppler-shifted emissions. These emissions appear mainly to the blue, representing motion of 20-30 km/sec up out of Jupiter's auroral atmosphere, and the presence of Doppler-shifted emission is now well tied to the presence of bright aurora. These velocities correspond to energies of 10-20 eV for fast protons or H atoms, and we interpret these motions as ionospheric plasma accelerated by local fields. The several-kR brightness of the Doppler-shifted